SOIL CONSERVATION SERVICE
WEST VIRGINIA

ENGINEERING STANDARD

POND SEALING OR LINING (No.)
Flexible Membrane Lining

Definition

Installing a fixed lining of impervious material or treating the soil in a pond mechanically or chemically to impede or prevent excess water loss.

Scope

This standard applies to the sealing of ponds with flexible membrane linings of plastic, rubber, or similar materials.

Purpose

To reduce seepage losses in ponds to an acceptable level and preserve or improve water quality.

Conditions Where Practice Applies

This practice applies where water loss from a pond through leakage is or will be of such proportion as to prevent the pond from fulfilling its planned purpose. This practice also applies where leakage will damage land and crops, cause waste of water or environmental problems.

Design Criteria

The design shall be based on adequate investigation and documentation of the leaking soil materials.

Ponds to be lined shall be constructed to meet SCS standards for irrigation pits or regulating reservoirs (552), irrigation storage reservoirs (436), ponds (378), wildlife watering facilities (648), waste treatment lagoons (359), or waste storage ponds (425), as appropriate.

Flexible membrane linings shall be constructed of high quality materials and shall be certified by the manufacturer to be suitable for this use. Pigmented polyvinyl or polyethylene plastics, rubber, and similar materials that are highly resistant to bacteriological deterioration are acceptable base materials.

All plastic membranes shall have a cover of earth, or earth and gravel, not less than 5 inches thick. Rubber membranes need not be covered unless the area will be traveled by livestock. In these areas, a minimum earth cover of 9 inches shall be used on all types of flexible membranes. The bottom 3 inches of cover shall not be coarser than silty sand (SM).

Quality of all membranes shall meet or exceed the attached specifications for polyethylene and rubber materials (tables 1 through 8). Polyvinyl chloride membranes shall meet requirements of ASTM D-3083 and table 4. Minimum nominal thickness shall be:

Soil Material Not Coarser Than	Plastic Sheeting	All Others	
		Reinforced	Unreinforced
	Mil	Mil	Mil
Sands (SM, SP, SW)	**8**	**20**	**30**
Gravels (GC, GM, GP, GW)	**12**	**30**	**30**

Plans and Specifications

Plans and specifications for sealing ponds with flexible membrane linings shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Operation and Maintenance

An operation and maintenance plan shall be prepared which includes as a minimum the following items:

1. Membranes installed on the surface shall be permanently protected from vehicular and animal traffic.

2. For covered linings, the depth of cover shall be checked at least annually and material added as necessary.

3. Leaks shall be repaired using materials and techniques specified for splices.

4. The pond shall be used in such a way that damage to the membrane liner is prevented.

MATERIALS SPECIFICATIONS

POND SEALING OR LINING

Flexible Membrane

Materials

All materials used to manufacture flexible membranes shall meet the requirements in tables 1 through 8 as appropriate. Written certification by the manufacturer or supplier is required.

Table 1.—Requirements for polyethylene and ethylene co-polymer plastic film

Test description	Requirements		Test method
	Type I polyethylene	Type II co-polymer	
Tensile strength, each direction, minimum average ..... lb/in.^{2}	1,800	2,000	ASTM-D-882, Method "A"
Ultimate elongation, each minimum average ..... pct	500	500	ASTM-D-882, Method "A"
Impact resistance, minimum average ..... g/mil	45	65	ASTM-D-1709, Method "B"
Water vapor permeability ..... perm-mil ...	0.7	1.5	ASTM-E-96
Tear resistance, each direction, minimum ..... g/mil	80	80	ASTM-D-1922
Soil burial			
Tensile strength change, each direction, maximum ..... pct	5	5	ASTM-D-3083
Elongation loss, each direction, maximum ... pct	20	20	
Luminous transmittance, maximum ..... pct	1.0	1.0	National Bureau of Standards Publication PS-17

Table 2.—Requirements for reinforced rubber sheeting

Test description	Requirements: Up to 20 mil thick	Requirements: 20 mil thick and greater	Test method
Breaking strength, minimum			ASTM-D-751
Warp direction ..... lb/in	75	100	
Fill direction ..... lb/in	75	100	
Ultimate elongation, maximum			ASTM-D-751
Warp direction ..... pct	30	30	
Ozone resistance, procedure "B"			ASTM-D-1149 and
50 pphm, 100°F ..... days	7	7	ASTM-D-518
Hydrostatic strength retained after			Federal Specification
ozone exposure, 7 days			CCC 191 b
(Mullen) ..... pct	100	100	Method 5512
			ASTM-D-518
Heat aging, 7 days at 212°F			ASTM-D-573
Tensile strength retained ..... pct	90	90	
Elongation retained ..... pct	90	90	
Tear resistance, minimum, warp or fill			ASTM-D-751 (tongue)
direction ..... lb	8	8	
Hydrostatic burst (Mullen), minimum ..... lb/in^2	100	175	ASTM-D-751
Dimensional stability, 7 days at 212°F			(1)
Change in length or width ..... pct	±1.0	±1.0	
Low-temperature flexibility (optional)			Federal Specification
No cracking or flaking	−40°F	−40°F	CCC 191 b, Method 5874
Commercial field splice strength			Commercial field splice
Shear force, minimum tensile ..... pct	75	75	1-in.-wide strip, pulled in shear at 10 in./min, after 7 days cure at room temperature

[1] A 1-ft^2 sample, 10-in. bench marks in warp and fill direction, placed on aluminum or stainless plate in changing air over.

Table 3.—Requirements for unreinforced rubber sheeting

Test description	Requirements: Type A	Requirements: Type B	Test method
Tensile strength, minimum ..... lb/in^2	1,200	1,200	ASTM-D-412
Modulus at 300% elongation, minimum ..... lb/in^2	600	600	ASTM-D-412
Ultimate elongation, minimum ..... pct	300	300	ASTM-D-412
Shore "A" hardness	60 ± 10	60 ± 10	ASTM-D-2240
Ozone resistance, procedure "A"			ASTM-D-1149
No cracks, 50 pphm at 100°F, 20%			
elongation ..... days	7	—	ASTM-D-518
No cracks, 100 pphm at 100°F, 50%			
elongation ..... days	—	7	ASTM-D-518
Heat aging, 7 days at 212°F			ASTM-D-573
Tensile strength retained ..... pct	75	75	
Elongation retained ..... pct	75	75	
Water vapor permeability at 80°F, maximum .... perm mil ...	0.002	0.05	ASTM-E-96 (procedure BW)
Tear resistance, minimum ..... lb/in^2	150	150	ASTM-D-624 Die "B"
Dimensional stability, 7 days at 212°F			
Change in length or width ..... pct	±0.5	±0.5	
Commercial field splice strength 60 shear force,			Commercial field splice,
minimum tensile ..... pct	60	60	1-in-wide strip pulled in shear at 10 in/min, after 7-day cure at room temperature.

NOTE: Type "A" sheeting is recommended for general-purpose outdoor use. Type "B" material is recommended for use if an extreme outdoor environment requires a highly weatherable lining.

Table 4.—Requirements of polyvinyl chloride plastic sheeting

Test description	Requirements	Test method
Tensile strength, each direction, minimum average ..... lb/in²	2,000	ASTM-D-882
Elongation at break, minimum ..... pct	250	ASTM-D-882, Method A
Volatile loss, maximum ..... pct	0.7	ASTM-D-1203, Method A
Tear resistance, each direction, minimum ..... g/mil	160	ASTM-D-1922
Resistance to soil burial (percent change maximum in original value)		ASTM-D-3083 (120-day soil burial)
Breaking factor ..... pct	−5	
Elongation at break ..... pct	−20	
Modulus at 100% elongation ..... pct	±10	
Bonded seam strength, percent breaking factor ..... pct	80	ASTM-D-3083 Para. 9.3 (1-in width)

Table 5.—Unreinforced chlorsulfonated polyethylene

Test description	Minimum requirements	Test method
Tensile strength, minimum pounds per square inch ..... pct	1,000	ASTM-D-412
Ultimate elongation, minimum ..... pct	250	ASTM-D-412
Ozone resistance, 50 pphm, 20% strain, 100°F, 8,000 hr ..... pct	±0	ASTM-D-1149
Heat aging, 14 days at 212°F		ASTM-D-412
Tensile strength, minimum pounds per square inch ..... pct	1,000	
Elongation at break ..... pct	150	
Tear resistance, minimum ..... lb/in	250	ASTM-D-624 Die B
Commercial field splice		ASTM-D-882, Method A
Strength, shear force, minimum tensile ..... pct	60	7 days cure
Weight change after 7 days at 70°C in water, maximum ..... pct	5	ASTM-D-471

Table 6.—Reinforced chlorsulfonated polyethylene

Test description	Minimum requirements 30 mils thick and greater	Test method
Breaking strength, minimum		ASTM-D-751
Rubber ..... lb/in	100	
Fabric ..... lb/in	75	
Ultimate elongation, maximum		ASTM-D-751
Rubber ..... pct	150	
Fabric ..... pct	20	
Ozone resistance, 50 pphm, 20% strain at 100°F, 8,000 hr ..... pct	±0	ASTM-D-1149
Hydrostatic strength after ozone exposure, 7 days (Mullen), percent retained ..... pct	100	Fed. Spec. CCC 191b Method 5512, ASTM-D-518
Heat aging, 14 days at 212°F of original		
Tensile strength ..... pct	90	
Elongation percent retained of original ..... pct	90	
Tear resistance, pounds minimum		ASTM-D-751
Warp or fill direction ..... pct	10	(Tongue)
Puncture resistance, pounds minimum ..... pct	120	FTMS 101B, Method 2031
Commercial field splice		
Strength—shear force, percent of minimum break ..... pct	75	ASTM-D-882, 7 days cure

Table 7.—Requirements for high density polyethylene (HDPE)

Test description	Requirements		Test method
	80 mils	100 mils	
Minimum tensile properties (each direction)			ASTM-D-638
1. Tensile strength yield (pounds/inch width)	120	150	
2. Tensile strength at break (pounds/inch width)	120	150	
3. Elongation at yield (percent)	10	10	
4. Elongation at break (percent)	500	500	
5. Modulus of elasticity (pounds/sq. in.)	80,000	80,000	
Tear resistance (pounds, minimum)	40	50	ASTM-D-1004
Low temperature	−40°F	−40°F	ASTM-D-746
Dimensional stability (each direction, percent change, maximum)	±3	±3	ASTM-D-1204 212°F, 15 min.
Resistance to soil burial[1] (percent change maximum in original value)			ASTM-D-3083 (120-day soil burial)
1. Tensile strength yield	±10	±10	
2. Tensile strength at break	±10	±10	
3. Elongation at yield	±10	±10	
4. Elongation at break	±10	±10	
5. Modulus of elasticity	±10	±10	
Bonded seam strength[2] (factory seam, breaking factor, pounds/inch width)	108	135	ASTM-D-3083
Environmental stress crack (minimum, hours)	500	500	ASTM-D-1693

[1]Test value of "after exposure" sample is based on precut sample dimension; 120-day test is required for initial certification.
[2]Factory bonded seam strength is the responsibility of the fabricator.

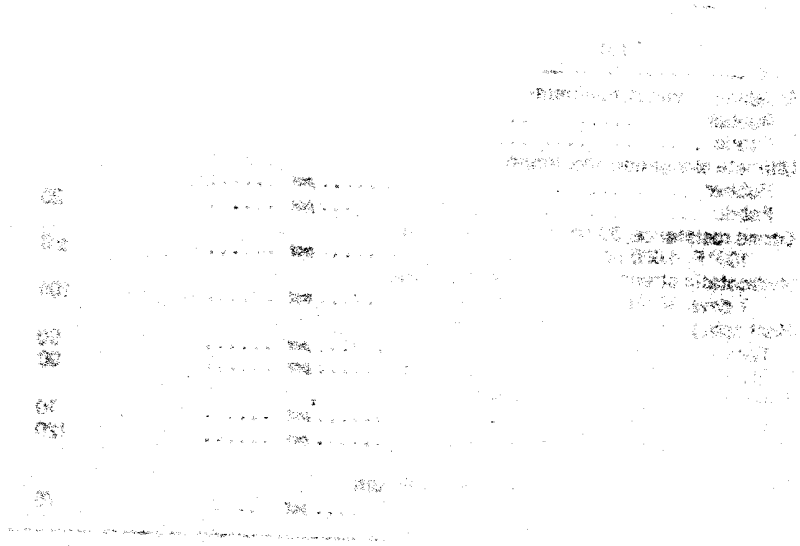

Table 8.—Requirements for supported extended polyurethane

Property	Test method	Supported finished material[2] Type 1	Type 2	Type 3	Type 4
Thickness	ASTM-D-751				
1. Overall (mils, minimum)		25	45	30	70
Minimum Tensile Properties	ASTM-D-751				
1. Breaking Strength—fabric TD		50	70	110	100
(pounds, minimum) MD		70	120	120	140
Breaking Strength — composites MD		90	160	130	220
TD		75	160	130	160
Tear Strength (pounds, minimum) composite	ASTM-D-751 Tongue Method 8 x 8-in sample				
1. Initial		2.5	4.5	35	4.5
2. After Heat Aging	212°F, 30 days	2.5	4.5	35	4.5
Low Temperature Composite	ASTM-D-2136 1/8 in mandrel, 4 hr, Pass	−40°F	−40°F	−40°F	−40°F
Unsupported sheet, 100 mils			below −60°F		
Dimensional Stability (each direction percentage change maximum)	ASTM-D-1204 212°F, 1 hr.	−0.8	−0.5	−1.3	−0.7
Resistance to Soil Burial[1] (percent change maximum in original values)	ASTM-D-3083 365-day soil burial 30-mil sheet (as modified in Appendix A)				
a. Unsupported sheet	ASTM-D-882				
1. Breaking Factor				+15	
2. Elongation at Break				−15	
3. Initial Modulus				+30	
b. Membrane Fabric Breaking Factor	ASTM-D-751	TBD	TBD	TBD	TBD
Bonded Seam Strength (pounds, minimum)	ASTM-D-751 (As modified in Appendix A, 12 in/min)		greater than single layer		
Hydrostatic Resistance (pounds per square inch, minimum)	ASTM-D-751 Method A, Procedure I	80	210	250	280
Ozone Resistance	ASTM-D-1149 (As modified in 7 days, 100 pphm 104°F, 1/8 in bent loop)			NA	
Ply Adhesion (each direction, pounds/in. width minimum)	ASTM-D-413 Machine Method Type A			NA	
Volatile Loss, percent (Unsupported)	ASTM-D-1203 Method A 30-mil sheet			0.4	
(Puncture Resistance, pounds)	FTMS 101B (Method 2065)	25	50	45	70

[1]Test value of "after exposure" sample is based on precut sample dimension; 120-day test is required for initial certification.
[2]Supporting Fabrics:
Type 1: Nylon 6.6 2.0 oz/yd^2
Type 2: Polypropylene 3.1 oz/yd^2
Type 3: Composite of 2 layers 0.5 oz/yd^2 nylon 6.6 plus 5 x 5 1000d polyester scrim (4.1 oz/yd^2 total)
Type 4: Polypropylene 4.4 oz/yd^2

Approved by _____	U.S. Department of Agriculture Soil Conservation Service Assisting _____	Cooperator _____
Date _____	Soil Conservation District	Sheet _____ of _____

CONSTRUCTION SPECIFICATION

POND SEALING OR LINING
Flexible Membrane

Subgrade Preparation

The area to be lined shall be drained and allowed to dry until the surface is firm and will support the men and equipment that must travel over it during installation of the lining.

All banks and fills within the area to be lined must be sloped not steeper than 1 to 1 for exposed lining or 2 1/2 horizontal to 1 vertical for buried lining.

Prior to placing the membrane, all fractured rock outcrops shall be covered to a minimum depth of 1 foot with compacted fine grained soil. Cavernous limestone shall have plugs of adequate strength to bridge openings wider than 3 inches (minimum cover of 2 feet of compacted fine grained soil is required). The foundation area for the flexible membrane lining shall be smooth and free of projections that might damage the lining. Stumps and roots shall be removed. Rocks, hard clods, and other such material shall be removed, rolled to provide a smooth surface, or covered with a cushion of fine grained soil material.

If needed, an effective sterilant shall be applied to the subgrade at the rate recommended by the manufacturer.

An anchor trench shall be excavated completely around the area to be lined at the planned elevation of the top of the lining. The trench shall be 8 to 10 inches deep and about 12 inches wide.

Placement

Lining membranes shall be loosely spread over the subgrade. Polyethylene lining requires about 5 percent slack for satisfactory results.

All field splices shall be made in accordance with the manufacturer's recommended technique, using materials furnished for the purpose. Splices shall be watertight and capable of maintaining their integrity throughout the expected life of the lining.

Approximately 8 inches of the top of the lining shall be placed in the anchor trench and secured with compacted backfill.

For covered membranes, the soil material used as cover shall be free of large clods, sharp rocks, sticks, and other objects that could puncture the lining. The cover shall be placed to the specified depth without damage to the lining.

Installation of the flexible membrane lining shall be done in such a manner that erosion and air and water pollution are minimized. The completed job shall present a workmanlike finish.

Approved by _____	U.S. Department of Agriculture Soil Conservation Service	Cooperator _____
_____	Assisting _____	_____
Date _____	Soil Conservation District	Sheet _____ of _____

Pond Sealing or Lining (no.)
Flexible Membrane 521-A

Planning considerations for water quantity and quality

Quantity

1. Effects upon components of the water budget , especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.

2. Potential use for water management.

Quality

1. Effects on the movement of silts, pathogens, and soluble materials carried by seepage toward the ground water.

2. Short-term and construction-related effects of this practice on the quality of the water resource.

3. Effects on wetlands or water-related wildlife habitats.

4. Effects on the visual quality of downstream water resources.

5. Effects on the use and management of nutrients and pesticides and their effect on surface and ground water quality.